UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/716,681	11/19/2003	Hartmut Ruelke	2000.108700	6568

23720 7590 06/22/2005

WILLIAMS, MORGAN & AMERSON, P.C.
10333 RICHMOND, SUITE 1100
HOUSTON, TX 77042

EXAMINER	
PHAM, THANHHA S	

ART UNIT	PAPER NUMBER
2813	

DATE MAILED: 06/22/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	10/716,681	RUELKE ET AL.	
	Examiner	Art Unit	
	Thanhha Pham	2813	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *03/07/05*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-27* is/are pending in the application.

4a) Of the above claim(s) *23* is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-22 and 24-27* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *19 November 2003* is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☒ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date *07/26/04*.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

This Office Action responses to Applicant's Election dated 03/07/2005.

Election/Restrictions

1. Claim 23 is withdrawn from further consideration pursuant to 37 CFR 1.142(b), as being drawn to a nonelected invention, there being no allowable generic or linking claim. Applicant timely traversed the restriction (election) requirement in the reply filed on 03/07/2005.

2. Applicant's election of claims 1-22 and 24-27 in the reply filed on 03/07/2005 is acknowledged. Because applicant did not distinctly and specifically point out the supposed errors in the restriction requirement, the election has been treated as an election without traverse (MPEP § 818.03(a)).

Oath/Declaration

3. Oath/Declaration filed on 11/19/2003 has been considered.

Claim Objections

4. Claims 2-3, 5-6, 13, 15 and 24 are objected to because of informalities. Appropriate corrections are required to clarify scopes of claims.

► With respect to claims 2-3 and 5-6, "said plasma atmosphere" lacking antecedent basis should be changed to "said inert plasma atmosphere" to clarify scopes of claims

► With respect to claim 13, "said barrier" and "said low-k barrier layer" lacking antecedent basis should be changed to "said nitrogen-containing low-k barrier layer" to clarify the scope of the claim.

► With respect to claim 15, line 2, grammatical error "is" should be changed to "are"

► With respect to claim 24, "first surface" and "first region" should be changed respectively to "surface" and "region" to clarify the scope of claim.

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

5. Claims 1, 3, 7-9, 11-14, 16, 19, 24-27 are rejected under 35 U.S.C. 102(e) as being as anticipated by Xu et al. [US 6,656,837].

► With respect to claims 1 and 3-4, Xu et al. (figs 1-4, abstract and cols. 1-17) discloses the claimed method comprising:

forming a nitrogen-enriched silicon carbide containing layer (512, fig. 4A, col. 14 lines 45-53 and cols. 3-8) over a substrate wherein said nitrogen-enriched silicon carbide containing layer is formed by plasma enchanced vapor deposition; and

modifying at least an exposed surface of said nitrogen-enriched silicon carbide containing layer by treating the exposed surface with an inert plasma atmosphere wherein said inert plasma atmosphere is substantially established from helium (col. 14 lines 54-67, col. 15 lines 1-3, col 7 lines 55-67, col 8 lines 1-39 and col. 3 lines 20-35)

► With respect to claims 7-8, Xu et al. (fig. 4A-4F, abstract, cols. 3-15) discloses forming a low-k dielectric layer (518) over said nitrogen-enriched silicon carbide containing layer and patterning said low-k dielectric layer by photolithography and etching. Due to the surface modification step (col 3 lines 20-35, col. 7 lines 31-67, col 8 lines 1-39 and col. 14 lines 54-62), diffusion of contaminants emanating from the nitrogen-enriched silicon carbide containing layer is reduced and resist poisoning is reduced by reduced diffusion of contaminants.

► With respect to claims 11-12, Xu et al. (col. 2 lines 25-46 and cols. 7-8) discloses determining a degree of the resist poisoning. Parameter for treating the surface with the plasma atmosphere of Xu et al would control the degree of resist poisoning.

► With respect to claims 13-16, Xu et al. (figs 1-4, abstract and cols. 1-17) discloses the claimed method comprising:

forming a nitrogen- containing low-k barrier layer (512, fig. 4A, col. 14 lines 45-53 and cols. 3-8) over a substrate wherein said nitrogen-containing low-k barrier comprises silicon carbide;

modifying a surface of said nitrogen-containing low-k barrier layer by introducing noble gas atoms into a region of said nitrogen-containing low-k barrier layer by exposing said nitrogen-containing low-k barrier layer to a plasma treatment comprising a noble

gas wherein depositing said nitrogen-containing low-k barrier layer and modifying said surface thereof is performed without exposing said substrate to ambient atmosphere wherein said plasma treatment includes establishing a plasma atmosphere on the basis of a noble gas (col. 14 lines 54-67, col. 15 lines 1-3, col 7 lines 55-67, col 8 lines 1-39 and col. 3 lines 20-35: *plasma treating the nitrogen-containing low-k barrier layer 512 would introducing noble gas atoms into exposed region of said nitrogen-containing low-k barrier layer*);

depositing a low-k dielectric (518, fig 4D) over said nitrogen-containing low-k barrier layer;

patterning said low-k dielectric layer by lithography process (figs 4A-F) wherein said modified surface reduces resist poisoning in said lithography process (col. 3 lines 20-35); and

forming a metal region (526, fig. 4H) in said patterned low-k dielectric layer.

► With respect to claims 24 and 26, Xu et al. (figs 1-4, abstract and cols. 1-17) discloses the claimed method comprising:

forming barrier layer comprised of a nitrogen- enriched silicon carbide-containing layer (512, fig. 4A, col. 14 lines 45-53 and cols. 3-8) over a substrate;

exposing a surface of said barrier layer to a plasma ambient comprising a noble gas to thereby increase a concentration of atoms of said noble gas in a first region of said barrier layer having a first depth wherein said noble gas is comprised at least one of helium, argon and krypton (col. 14 lines 54-67, col. 15 lines 1-3, col 7 lines 55-67, col 8 lines 1-39 and col. 3 lines 20-35: *plasma treating the nitrogen-containing low-k barrier layer 512 would introducing noble gas atoms into exposed region of said nitrogen-containing low-k barrier layer*);

forming at least one dielectric layer (510, fig 4A) above said barrier layer after said first surface of said barrier layer is exposed to said plasma ambient; and

forming a conductive interconnection in said at least one dielectric layer (526, fig. 4H).

6. Claims 1-4, 7-9, 11-16, 19, 21-22, 24 and 26 are rejected under 35 U.S.C. 102(e) as anticipated by Ruelke et al. [US 2004/0084680].

► With respect to claims 1-4, Ruelke et al (figs. 2's, abstract and text [0001]-[0053]) discloses the claimed method comprising:

forming a nitrogen-enriched silicon carbide containing layer (250, fig. 2f, text [0035]-[0038]) over a substrate wherein said nitrogen-enriched silicon carbide containing layer is formed by plasma enchanced vapor deposition; and

modifying at least an exposed surface of said nitrogen-enriched silicon carbide containing layer by treating the exposed surface with an inert plasma atmosphere wherein said plasma atmosphere is established without interrupting a vacuum condition generated during the formation of said nitrogen-enriched silicon carbide-containing layer wherein said plasma atmosphere is substantially established from helium (text paragraph [0039]-[0040]).

► With respect to claims 7-9, Ruelke et al. (figs 2f-2j, text [0044]-[0049]) discloses forming a low-k dielectric layer (206) over nitrogen-enriched silicon carbide-containing layer (250), patterning said low-k dielectric layer by photolithography and etching wherein said patterning said low-k dielectric layer including forming a via in said low-k dielectric by means of a first resist mask and forming a trench in said upper portion of

said low-k dielectric layer by means of a second resist mask. Diffusion of contaminants emanating from said nitrogen-enriched silicon carbide-containing layer would be reduced due to the surface modification wherein resist poisoning is reduced by said reduced diffusion of contaminants.

► With respect to claims 11-12, Ruelke et al (text [0012], [0032], [0039]-[0040]) discloses determine a degree of the resist poisioning. Parameter for treating the surface with the plasma atmosphere of Ruelke et al would control the degree of resist poisoning.

► With respect to claims 13-16, Ruelke et al (figs. 2's, abstract and text [0001]-[0053]) discloses the claimed method comprising:

depositing a nitrogen-containing low-k barrier layer (250, fig. 2f, text [0035]-[0038]) over a substrate wherein said nitrogen-nitrogen containing low-k barrier layer comprises silicon carbide;

modifying a surface of said nitrogen-containing low-k barrier by introducing noble gas atoms into a region of said barrier layer by exposing said barrier layer to a plasma treatment comprising a noble gas (text [0039]-[0040]: *the plasma treatment with parameter as shown in text [0039] would introduce noble gas atoms into a region of the barrier 250*) wherein depositing said nitrogen-containing low-k barrier layer and modifying said surface thereof is performed without exposing said substrate to ambient atmosphere wherein said plasma treatment includes establishing a plasma atmosphere on the basis of a noble gas;

depositing a low-k dielectric layer (206, fig. 2f) over said nitrogen-containing low k barrier layer (250);

patterning said low-k dielectric layer by lithography process (see figs 2f-2i), wherein said modified surface reduces resist poisoning in said lithography process; and

forming a metal region (219, fig. 2j) in said patterned low-k dielectric layer (206).

► With respect to claim 19, Ruelke et al (figs 2's) discloses patterning the low-k dielectric layer.

► With respect to claim 21-22, Ruelke et al (text [0012], [0032], [0039]-[0040]) discloses determine a degree of the resist poisioning. Parameter for treating the surface with the plasma atmosphere of Ruelke et al would control the degree of resist poisoning.

► With respect to claims 24 and 26, Ruelke et al (figs. 2's, abstract and text [0001]-[0053]) discloses the claimed method comprising:

forming barrier layer comprised of a nitrogen- enriched silicon carbide-containing layer (250, fig. 2f, text [0035]-[0038]) over a substrate;

exposing a first surface of said barrier layer to a plasma ambient comprising a noble gas to thereby increase a concentration of atoms of said noble gas in a first region of said barrier layer having a first depth wherein said noble gas is comprised at least one of helium, argon and krypton (text [0039]-[0040]: *plasma treating the barrier layer of the nitrogen-enriched silicon carbide-containing layer 250 would introduce noble gas atoms into exposed region of said barrier layer*);

forming at least one dielectric layer (510, fig 4A) above said barrier layer after said first surface of said barrier layer is exposed to said plasma ambient; and

forming a conductive interconnection in said at least one dielectric layer (526, fig. 4H).

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

7. Claims 23 and 27 are rejected under 35 U.S.C. 103(a) as being unpatentable over Xu et al [US 6,656,837].

With respect to claim 23 and 27, the claimed range percentage of nitrogen in the nitrogen-enriched silicon carbide-containing layer and the claimed range of first depth are considered to involve routine optimization while has been held to be within the level of ordinary skill in the art. As noted in In re Aller 105 USPQ233, 255 (CCPA 1955), the selection of reaction parameters such as temperature and concentration would have been obvious.

"Normally, it is to be expected that a change in temperature, or in concentration, or in both, would be an unpatentable modification. Under some circumstances, however, changes such as these may be impart patentability to a process if the particular ranges claimed produce a new and unexpected result which is different

in kind and not merely degree from the results of the prior art...such ranges are termed "critical ranges and the applicant has the burden of proving such criticality... More particularly, where the general conditions of a claim are disclosed in the prior art, it is not inventive to discover the optimum or workable ranges by routine experimentation."

See also In re Waite 77 USPQ 586 (CCPA 1948); In re Scherl 70 USPQ 204 (CCPA 1946); In re Irmscher 66 USPQ 314 (CCPA 1945); In re Norman 66 USPQ 308 (CCPA 1945); In re Swenson 56 USPQ 372 (CCPA 1942); In re Sola 25 USPQ 433 (CCPA 1935); In re Dreyfus 24 USPQ 52 (CCPA 1934).

8. Claim 27 is rejected under 35 U.S.C. 103(a) as being unpatentable over Ruelke et al [US 2004/0084680].

With respect to claim 27, the claimed percentage of nitrogen in the nitrogen-enriched silicon carbide-containing layer is considered to involve routine optimization while has been held to be within the level of ordinary skill in the art. *See In re Aller 105 USPQ233, 255 (CCPA 1955); In re Waite 77 USPQ 586 (CCPA 1948); In re Scherl 70 USPQ 204 (CCPA 1946); In re Irmscher 66 USPQ 314 (CCPA 1945); In re Norman 66 USPQ 308 (CCPA 1945); In re Swenson 56 USPQ 372 (CCPA 1942); In re Sola 25 USPQ 433 (CCPA 1935); In re Dreyfus 24 USPQ 52 (CCPA 1934).*

9. **Claims 5-6 and 17-18 are rejected under 35 U.S.C. 103(a) as being unpatentable over Xu et al. [US 6,656,837] as applied to claims 1 or 16 above in view of Tu et al [US 5,962,344].**

Xu et al (col 7 lines 45-67 and col. 8 lines 1-39) substantially discloses the claimed method including generally purging the substrate with noble gas helium used to establish said plasma atmosphere, stabilizing a gas atmosphere including helium used to establish said plasma atmosphere and stablishing said plasma atmosphere. Xu et al does not expressly show the sequence of purging the substrate with noble gas He and stabilizing the gas atmosphere prior to establishing said plasma atmosphere. However, the claimed invention is still obvious over Xu et al. since selection of any order of performing process steps is prima facie obvious in the absence of new or unexpected results. See In re Burhans, 154 F.2d 690, 69 USPQ 330 (CCPA 1946). See also In Ex parte Rubin , 128 USPQ 440 (Bd. App. 1959) (Prior art reference disclosing a process of making a laminated sheet wherein a base sheet is first coated with a metallic film and thereafter impregnated with a thermosetting material was held to render prima facie obvious claims directed to a process of making a laminated sheet by reversing the order of the prior art process steps.); In re Gibson, 39 F.2d 975, 5 USPQ 230 (CCPA 1930) (Selection of any order of mixing ingredients is prima facie obvious.).

Moreover, Tu et al (table I, col. 4 lines 10-62) shows stabilizing the gas atmosphere including He and purging the substrate with noble gas He (stabilizing step 4, table I) prior to establish the plasma atmosphere (step 5 of table I).

Therefore, at the time of invention, it would have been obvious for those skilled in the art to modify process of Xu et al by stabilizing the gas atmosphere and purging the substrate with the noble gas prior to establishing the plasma atmosphere as being claimed, per taught by Tu et al, to provide a better control for plasma treating process.

10. Claims 5-6 and 17-18 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ruelke et al [US 2004/0084680] as applied to claims 1 or 16 above in view of Tu et al [US 5,962,344].

Ruelke et al substantially discloses the claimed method but does not expressly teach purging the substrate with a noble gas He used to establish said gas plasma atmosphere and establishing a stabilized gaseous atmosphere including He used to subsequently establishing said plasma atmosphere prior to establish said plasma atmosphere.

However, such claimed steps of purging the substrate and stabilizing the gas atmosphere using the gas to establish the plasma atmosphere prior to establish the plasma atmosphere are conventional and has been known in the art. See Tu et al (table I, col. 4 lines 10-62) as an evidence that shows stabilizing the gas atmosphere including He and purging the substrate with noble gas He (stabilizing step 4, table I) prior to establish the plasma atmosphere of He (step 5 of table I).

Therefore, at the time of invention, it would have been obvious for those skilled in the art to modify process of Ruelke et al by stabilizing the gas atmosphere and purging the substrate with the noble gas prior to establishing the plasma atmosphere as being claimed, per taught by Tu et al, to provide a better control for plasma treating process.

11. Claims 10 and 20 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ruelke et al [US 2004/0084680] as applied to claims 9 and 19 above in view of Wu et al. [US 6,720,256].

Ruelke et al substantially discloses the claimed method comprising patterning the low k dielectric layer including forming the via in said low-k dielectric layer by means of the first resist mask and forming the trench in the low-k dielectric layer by means of the second resist mask. Ruelke et al does not expressly teach performing an out-gassing step to remove contaminants prior to forming the trench.

However, Wu et al (fig. 4c-4e, col. 6 lines 38-54) discloses performing an out-gassing step to remove contaminants (heating to remove solvent) prior to forming the trench.

Therefore, at the time of invention, it would have been obvious for those skilled in the art to modify process of Ruelke et al by performing the out-gassing step as being claimed, per taught by Wu et al, to improve the process of forming the trench using photolithography technique.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Thanhha Pham whose telephone number is (571) 272-1696. The examiner can normally be reached on Monday and Thursday 9:00AM - 9:30PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Carl Whitehead can be reached on (571) 272-1702. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Thanhha Pham
Patent Examiner
Patent Examining Group 2800